PUBLICATION 591
TECHNICAL BULLETIN 12

ISSUED NOVEMBER, 1937
FIRST PRINTING

DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE



# THE PRESERVATION OF FRUITS AND VEGETABLES BY FREEZING

R. W. ARENGO-JONES



DIVISION OF HORTICULTURE
EXPERIMENTAL FARMS BRANCH

Published by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture,
Ottawa, Canada

5M—562-9-37

## TABLE OF CONTENTS

# THE PRESERVATION OF FRUITS AND VEGETABLES BY FREEZING

## INTRODUCTION

Freezing is now well established as a method for preserving fruits and vegetables, and the popularity of frozen products is increasing rapidly.

The information contained in this bulletin should be of value to the small producer as well as to the large. It is based upon experimental work conducted at Ottawa using Canadian materials and Ontario grown fruits and vegetables.

A great many methods of freezing have been patented—contact, brine fog and immersion—all possessing certain desirable features and many having decided advantages. It is not the purpose, however, of this publication to weigh the merits of any of these methods, for their adoption by the packer is a matter of personal selection.


Freezing in its simplest form consists of preparing and packing the raw material in a suitable container and freezing it in a room cooled to a temperature of 0°F. or lower. The freezing may be hastened, and it is desirable to do so, by allowing for free circulation of air and by assisting this with an electrically driven fan.

Varietal influence is probably the most important factor governing the quality of the final product, and over a period of three years most of the known varieties grown in Ontario and a great many hybrid varieties of fruits and vegetables have been tested at the Fruit Products Laboratory of the Central Experimental Farm at Ottawa. Although certain recommendations are made in this bulletin, it is strongly advised that varieties be tested before any are packed in any great quantity, for a variety found suitable at Ottawa may not be suitable elsewhere.

43916—1½

## PACKING METHODS AND CONTAINERS

Frozen fruits and vegetables may be packed in two ways: wet and dry.

In wet packing, the fruits or vegetables are placed in a watertight container, covered with a prepared sugar syrup or brine, closed in the container and then frozen. The advantage of wet packing is that the liquid covering prevents desiccation and contact of the product with the air, thus reducing oxidation. Disadvantages of the method are the cost of preparing and adding the syrup and brine, the considerably increased shipping weight, and the waste of shipping container space because of the cylindrical packages.

For dry packing, rectangular paperboard containers are used. As these cannot be made air-tight or moisture-proof, they must be lined with moisture-proof material, such as a suitable grade of cellophane; the sealed package should also be wrapped with moisture-proof material, preferably heat sealing. The saving of shipping weight and space are points in favour of dry packing.

Under Canadian conditions and until better facilities are available for freezing and storage, the wet packing method is recommended, for it has been found to give better and more staple products.

## TRANSPORTATION

Transportation of frozen products is no great problem in Canada during the winter months, but when higher temperatures prevail, refrigerated railway cars or trucks should be used. The frozen products should never be allowed to defrost or to thaw out during transportation. Double-walled, fibreboard shipping containers are recommended; in these, frozen products will withstand about eight hours at elevated temperatures. If shipped during the warmer months, the containers should be closely loaded and protected from air currents by being covered with a tarpaulin.

## FRUITS

Fruits to be frozen should be firm, ripe and well coloured. Immature and over-ripe fruits should be graded out and particular attention should be paid to freshness. During the course of preparation and packing, soft fruits should be handled with the greatest of care as surface damage will result in discoloration of the affected part. For this reason washing, if by dipping, should be done in small batches to prevent crushing. Spraying the fruit with water, the fruit being in shallow perforated trays or on a perforated belt, will wash it with the minimum damage. This method is especially suitable for strawberries.

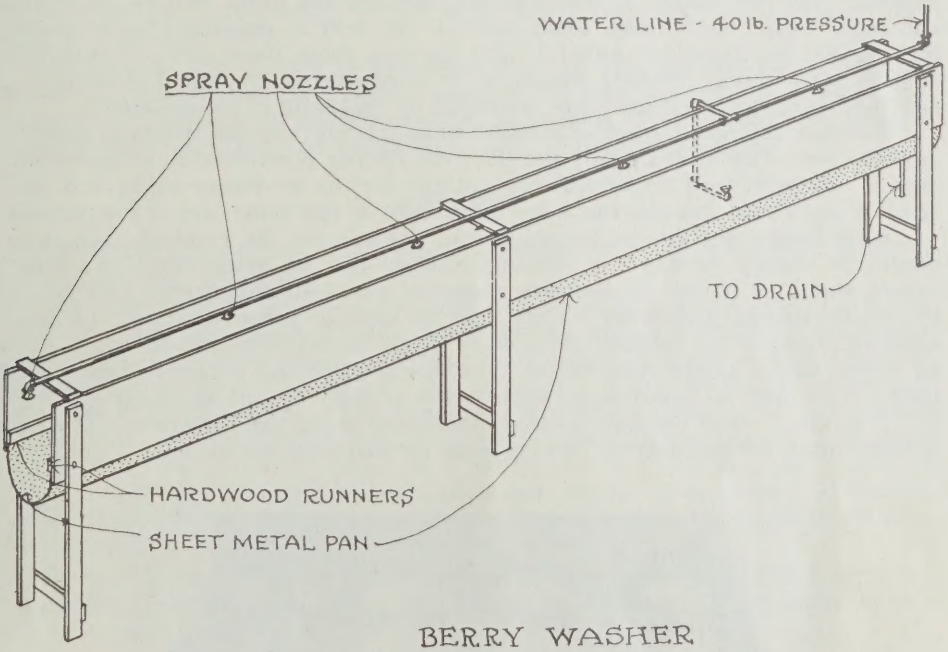
Trays may be constructed of wood and wire netting or of hardware cloth with four meshes to the inch. The fruit should be hulled directly into the trays and sprayed with a fine rain of water from both above and below. It may then be filled into the cartons directly from the trays and thus is handled but twice. Large quantities may be washed if a tunnel is constructed, say ten trays' length, piped and fitted with sprays above and below the line of trays passing through it. If the tunnel is fitted with metal or hardwood runners, ten trays can be pushed through by hand.

Suitable containers for soft fruits are waxed fibreboard cartons, lacquered metal pails or hardwood barrels. The cartons, in pint or quart sizes, are suitable for the retail trade. They should be water-tight and may be made for slip covers or for mechanically crimped-on covers. Waxing on the inside is desirable. Pails of 20 to 30 pounds capacity are suitable for restaurant or institutional use and barrels are generally used to freeze fruit for use in jam-making.

## STRAWBERRIES

As strawberry varieties vary a great deal in their freezing qualities, experimental work should be done, before packing them in commercial quantities, to determine the most suitable variety in the locality for the whole-fruit pack. The type of strawberry found to freeze best is full but not rich flavoured, medium acid, firm, pink-fleshed, coreless and small seeded. The rich-flavoured, deep-coloured sorts have usually been found to develop a "preserved" flavour. In the acid types the sharpness appears to increase and affects the palate as a harsh, almost "metallic" flavour. The juicy varieties, particularly the Chiloensis types, soften excessively. Premier, grown on the Niagara Peninsula and in the Toronto district, has been found to be satisfactory and has been frozen commercially for several years. Senator Dunlap grown on the Island of Orleans in Quebec has also proved satisfactory, but is inclined to be soft in a wet season. At Ottawa, several Central Experimental Farm varieties have been found to freeze very well; outstanding among these are Henry and Ralph.

The colour, flavour and texture of strawberries are best retained by freezing with sugar. The sugar is added as a prepared syrup or in dry form, the syrup method being used for the whole-fruit pack and the dry sugar method for sliced or crushed packs and for bulk freezing in barrels.




BERRY WASHER

For a whole-fruit pack in cartons, the fruit is hulled, washed and packed into the cartons. It is then covered with sugar syrup testing 55° Balling, capped and frozen. As strawberries will oxidise rapidly and thus acquire a "preserved fruit" flavour, not more than two or three hours should elapse between packing and placing in the freezing room. 55°B. syrup is prepared by dissolving 12 pounds of sugar in 1 gallon of water, this mixture giving almost $1\frac{3}{4}$ gallons of syrup. The syrup may be prepared cold and strained through flannelette before use, or, if there is any doubt as to the sterility of the water and sugar, it may be dissolved in hot water, boiled for a few minutes, strained hot and then cooled. If boiled, allowance must be made for evaporation, or the yield

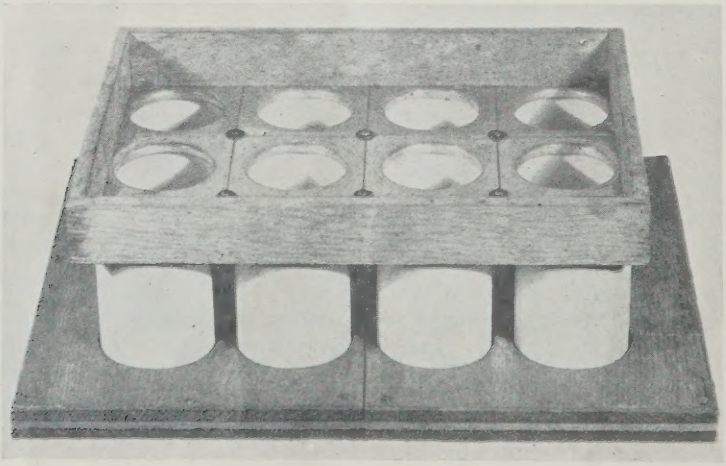
of syrup will be less than calculated. Only pure, white cane sugar should be used, and if the syrup is prepared in quantity it should not be allowed to stand in a container or place that might taint it.

As the pail pack is used largely by the baking trade, it is desirable in this pack to use the minimum quantity of syrup. The fruit is packed with dry sugar in the proportion of two parts of fruit and one part of sugar, a 2 + 1 pack. Thus a 30-pound pail will contain 20 pounds of berries and 10 pounds of sugar. The fruit is hulled, washed, and then placed in wooden pails or other suitable containers, each containing exactly 20 pounds. The sugar is also weighed out in 10-pound lots. The fruit and sugar are then layered into lacquered metal pails, the sugar thus being evenly distributed. As each layer of fruit is placed in the pail it should be pressed down slightly with a suitable instrument. The fruit should not be crushed, but only flattened. This will assist in dissolving the sugar and by driving out the air will result in a better flavoured and better coloured product. The pails should be fitted with slip covers, and should be placed in the freezing room about one hour after packing.

For the barrel pack the 2 + 1 formula is also used, but the fruit may be packed 3 + 1 or 4 + 1 as desired. The fruit is prepared and weighed, and the sugar is weighed as for the pail pack. The fruit and sugar are then layered into the barrel which is rocked steadily to pack down the contents. After the head is fitted, the barrel is weighed and marked with the gross, tare and net weights. The net weight is then divided, showing the exact weights of berries and sugar used. As it takes some time for the cold to penetrate barrel packs, they should be turned or rolled in the freezing room once every twenty-four hours for ten days. Barrels should be of hardwood impregnated with wax if new, and thoroughly cleaned and sterilized by steaming if second-hand.

Varietal difference is not so marked when strawberries are frozen in crushed or sliced form with added sugar, and the fresh flavour is retained to a remarkable degree. Crushed fruit is particularly suitable for the ice-cream trade, and both crushed and sliced strawberries have many uses in the home and in institutions.

Strawberries should not be reduced to a purée for the crushed pack; they should be merely broken. A suitable crusher can be made from two fluted rollers about 18 inches in diameter mounted on a suitable frame and geared to revolve against each other. They may be hand or power operated. A sheet aluminum pan is set beneath the rollers to catch the pulp and to guide it to an outlet, and a hopper may be set over and between the rollers to feed in the fruit. The pulp is mixed with sugar—two of fruit to one of sugar (2 + 1), 3 + 1 or 4 + 1—and the mix is stirred until the sugar has dissolved. The mix is then frozen immediately in cartons, cans or lacquered metal pails.



Simple Filling Device Consisting of Board and Filling Tray

Some markets prefer the sliced pack, although it has been found that the crushed pack retains better flavour than the sliced. Several suitable types of slicing machines are manufactured. The slices, which should be about one-eighth of an inch thick, are packed in cartons, cans or pails with added sugar (2, 3 or 4 + 1). An hour or so should be allowed after packing for the sugar to dissolve; then the pack is frozen.

Neither the crushed nor the sliced packs should be frozen in barrels as the freezing is too slow.

### RASPBERRIES

Most of the commercially grown varieties of red raspberries are suitable for freezing. Latham, Newman, Adams, Viking, Brighton, Count, Newburg and Ulster have all been found satisfactory. Cuthbert and other dark-coloured varieties do not present as attractive an appearance as the light-coloured, brighter sorts. There should be plenty of flavour in the fresh fruit and the acidity should not be too high. Large-seeded varieties and those having the number of drupelets on each fruit larger than average should be avoided as the seeds impart a woody flavour.

In the preparation of raspberries, washing is not advisable unless the berries are very firm; they usually grow high enough from the ground to be free from sand. They should be sorted by hand to remove imperfect fruits, leaves, stems, etc., and sandy berries may then be set aside to be washed and used for a crushed pack.

Raspberries are packed in the same way as strawberries, except that in the whole-fruit carton pack a lighter sugar syrup may be used. A 45°B. syrup, prepared by dissolving $8\frac{1}{4}$ pounds of sugar in 1 gallon of water, is heavy enough. These amounts of sugar and water will yield $1\frac{1}{2}$ gallons of syrup.

### CHERRIES

Sweet cherries may be frozen with dry sugar or with syrup, but the syrup pack favours best quality.

The large black varieties have been found more suitable than the Royal Anne type, the latter being somewhat insipid and having a tendency to develop oxidized flavours. Of the black varieties, Hedelfingen, Windsor and the Vineland Seedling 160119 have been found most suitable. Black Tartarian is too soft and Schmidt lacks flavour. The cherries are pitted mechanically and packed immediately. For the syrup pack 25° syrup is sufficiently strong. This is made by dissolving $3\frac{1}{3}$ pounds of sugar in 1 gallon of water (making $1\frac{1}{5}$ gallons of syrup). If cherries are packed with dry sugar the 3 + 1 or the 4 + 1 formula is generally used, and sufficient time should be allowed for the sugar to dissolve before freezing.

Sour cherries, known to the trade as red sour pitted or R.S.P. cherries, are packed for pie making. The pitted cherries are frozen with sugar—4 + 1 or 5 + 1—in pails or barrels.

### PEACHES

Few of the varieties of peaches grown in Ontario have been found suitable for freezing, for all have a tendency to brown more or less rapidly. The "V" varieties, of which Vedette was found the best, oxidize slower than most other varieties and for this reason this variety is recommended for sliced packs.

Peaches may be frozen in sliced form with syrup or may be pulped with dry sugar. Peeling is facilitated by lye dipping or by scalding the fruit; the skin is then slipped off by hand. The fruit is then halved and the pit is lifted out with the knife.

For the sliced pack each peach half is cut in about six longitudinal slices which are immediately placed in cartons and covered with sugar syrup, light (35°B.) or heavy (50°B.). Peach slices packed in heavy syrup have been found to retain best flavour and texture, but they might be considered too sweet for some tastes.

For the pulped pack the peach halves are crushed and immediately mixed with sugar, 3 + 1 or 4 + 1. The pulp is stirred until the sugar has dissolved and then is frozen in cartons or pails.

Elberta, the variety available in the largest quantity in Ontario, has been found to retain very good flavour; but it is subject to rapid browning. For this reason it is not recommended for sliced packs, but it is quite suitable for pulp. After they have been peeled and pitted, the halves may be dipped in boiling water for about two minutes, then chilled in cold water and allowed to drain for ten minutes before pulping. This treatment inactivates the oxidizing enzymes and gives a better coloured product.

### BLUEBERRIES

Blueberries may be frozen with or without sugar. For dessert purposes better flavour and texture are retained by freezing them in light syrup. The fruit should be sorted carefully and leaves, stems and imperfect berries removed. Blueberries are frequently frozen in the original shipping boxes for use by bakeries in pie making. When frozen in this way, berries have been found to suffer less damage in small containers than in large ones, because the outside berries, freezing first, crush those in the centre of the box.

Wild blueberries have been found to retain better flavour than the cultivated high-bush varieties, though the latter retain an excellent appearance.

### GOOSEBERRIES

Green gooseberries retain almost perfect quality when frozen. For dessert purposes they are best frozen under heavy syrup, but they may be packed either in water or dry for sale to bakeries or institutions for pie and tart making.

Green gooseberries should be harvested when fully developed but still green and firm. Topping and tailing is done by a special machine.

## VEGETABLES

### BLANCHING OF VEGETABLES

Unlike fruits, vegetables must be blanched before freezing or objectionable "hay-like" flavours will develop. Blanching is a process that should be given particular attention as upon it largely depends the quality of the final product. For freezing purposes the object of the blanch is to destroy catalytic enzymes which would otherwise cause flavour spoilage. Storage at extremely low temperatures will check their action, but storage at these temperatures is not practical at the present time. A simple test for catalase is described by Tressler and Evers.*

"A definite weight of sample, three-tenths of a gram of peas (1 small pea or half a large one) or 0·15 grams of spinach is about the right size, is ground for two minutes in a glass or glazed porcelain mortar with 0·25 grams of finely ground calcium carbonate and one gram of clean sand. Five cubic centimeters of distilled water (at about 70°F.) are added and the grinding continued for

* In "The Freezing Preservation of Fruits, Fruit Juices and Vegetables."

about one minute, after which 3 c.c. more of distilled water are added and the whole mixed thoroughly and transferred to a graduated fermentation tube (capacity about 12·5 c.c., 10 c.m. arm) containing 5 c.c. of high grade hydrogen peroxide which has been previously placed in the graduated arm. The tube is then tilted to a position in which the solution runs into the graduated arm. While in this position the tube is shaken lightly so that the air is eliminated and the solution fills the arm completely. The tube is then righted and shaken lightly for exactly three minutes. At the end of this period the volume of gas (oxygen) in the tube is noted . . . . . ."

Tests are conducted using the same weights of thoroughly cooked and raw, not blanched, vegetable. The test on the latter will give an indication of the amount of active catalase in the raw material. Just sufficient blanching should be given so that the amount of gas produced does not exceed that produced by the cooked sample.

In practice, the blanching process consists of a short cooking in boiling water or steam followed immediately by cooling in fresh cold water. Commercial blanching equipment is ideal for this purpose, but small quantities of vegetables may be blanched by dipping them in a kettle or tub of boiling water, using perforated baskets constructed of wicker, galvanized iron, tin or other impervious metals. The boiling water should be changed frequently to ensure freshness, and there should be sufficient volume to hold it at boiling temperature when the cold vegetables are put in. The cold dip should be, if possible, in running water. The water should be drinkable, clear and not too hard.

As a general rule, the freezing of vegetables under brine is recommended. Fibreboard containers of pint, quart, half-gallon or gallon capacity may be used, the containers being packed with the blanched vegetables and then filled to within one-quarter of an inch from the top with brine of the recommended strength. If vegetables are packed dry, moisture-proof containers must be used.

## ASPARAGUS

The Mary Washington variety has been found well suited to the freezing process.

The stalks should be processed as soon after cutting as possible as asparagus deteriorates rapidly. Thorough washing is necessary to remove sand, using warm water if the sand is under the petals.

To conform with the regulations, asparagus tips must be cut not more than $4\frac{1}{2}$ inches long, the remainder of the stalk, if tender, is packed separately as cuttings together with odd sized or mis-shapen tips.

Both the tips and the cuttings should be blanched for $2\frac{1}{2}$ minutes in boiling water, or sufficiently long in steam to inactivate the catalase, and then chilled in cold water. For wet packing a 2 per cent brine is used, this being added immediately after the cartons are filled with the asparagus. If asparagus is dry packed the containers should be sealed immediately after packing.

If cylindrical cartons are used the following method facilitates packing. Wood forms, slightly larger in diameter than the container and about 2 inches deep, are packed with the washed tips. The bunches are then tied with string or secured with rubber bands. The bunches are then blanched, chilled and slipped into the carton, the string or band being removed when the butt end of the bunch has been fitted into the carton. In this way the cartons may be tightly packed without damaging the stalks. As the bunches are very compact the blanch water should be kept at a full rolling boil to ensure that it circulates thoroughly through them.

## PEAS

Of 110 varieties of peas frozen at Ottawa the following have been selected as being most suitable for the process.

Sweet type—large. Thomas Laxton, Delicious, Duke of Albany, Market Garden, Telephone, Director and Kootenay. Of these, Duke of Albany is specially recommended.

Sweet type—medium. Witham Wonder, Copenhagen Market and Lincoln.

Sweet type—small. Michaux Common.

Not sweet—large. Laxton Gradus.

Not sweet—medium. Little Gem, Meteor.

Not sweet—small. Alderman, Early Crocket.

Varietal adaptability of peas is influenced by climatic and soil conditions, and it is recommended that several varieties be tried out before large quantities are packed.

Peas should be blanched and packed as soon after shelling as possible. A 2-minute blanch in boiling water is sufficient for large peas; smaller peas require about 1½ minutes. Small amounts of peas may be blanched in tubs or kettles of boiling water, the peas being placed in a perforated or wire basket; the blanch water must be changed frequently to ensure freshness. Following blanching, the peas must be chilled in cold, preferably running, water.

Peas may be packed with brine in cartons or dry in suitable packages. Wet-packed peas retain somewhat better colour than those dry-packed, but they tend slightly to toughen because of water withdrawal. Dry-packed peas will toughen unless held in moisture-proof containers.

## WAX BEANS

Pencil Pod Black Wax has been found to freeze best at Ottawa. Only tender stringless pods should be used, but they should be sufficiently far advanced in maturity to have a uniform yellow colour.

Following trimming and washing, the beans should be blanched for 2 minutes, chilled, and packed either with 2 per cent brine or dry in moisture-proof containers.

## GREEN BEANS

Kentucky Wonder has been found to be the variety of green bean most suitable for freezing. The pods should be harvested when about 4 inches long. They are prepared and packed in the same way as wax beans.

## LIMA BEANS

Henderson Bush and Burpee Bush are the varieties found to be most suitable in Ontario. The beans should be shelled while green, blanched for 2 to 3 minutes in boiling water and packed either with 2 per cent brine or dry in moisture-proof containers. Lima Beans retain almost perfect quality when frozen.

## CORN

Dorinny has been found to have excellent qualities for freezing preservation. Golden Bantam is also considered to be very good, but it lacks the size and uniformity of Dorinny.

To retain the finest flavour corn should be picked in the late milk or very early dough stage of maturity and packed within a few hours of harvesting. Following husking and silking, the corn is blanched in boiling water, 3 minutes if on the cob and 2 minutes for kernels cut from the cob. Both styles may be packed either with 2 per cent brine or dry in moisture-proof containers.

### SPINACH

Conditions of soil and climate affect the quality of spinach for freezing, a long growing season favouring the highest quality. If grown under suitable conditions all the common varieties of spinach have been found suitable, the Savoy types being considered slightly superior to the Broadleaf types.

Very careful washing is necessary to remove all the sand from the leaves. Spinach should be blanched for 2 minutes in small quantities in boiling water, or in a rotary steam blancher for large packs. Following thorough cooling, the spinach is packed either under 2 per cent brine or dry, the former in cartons and the latter in cartons or sealed, moisture-proof packages. As the blanched spinach leaves form a dense mass, brine filling is difficult and slow, but it can be hastened by forming a hole with a suitable instrument in the centre and from the top to the bottom of the pack.

### CAULIFLOWER

Cauliflower has been found to freeze very well, all table varieties being suitable.

The heads are cut or broken in small pieces, trimmed and blanched for 2 minutes in boiling water. Wet or dry packing may be used, 2 per cent brine being recommended for the former.

### BRUSSEL SPROUTS

Brussel Sprouts have been found to retain very good quality when frozen. The sprouts should be cut when quite firm, trimmed, washed and blanched for 3 minutes in boiling water. Wet packing, with 2 per cent brine, results in a better coloured product than does dry packing.

### BROCCOLI

Broccoli is well adapted to freezing preservation, retaining excellent colour and flavour. The bunches should be cut into smaller pieces, trimmed, washed and blanched for 2 minutes. Wet or dry packing may be used, the former with 2 per cent brine and the latter in moisture-proof containers.

### RHUBARB

Rhubarb has been successfully frozen, the colour, texture and flavour being excellently preserved. Ruby, New Zealand and Macdonald, on account of their colour, make the most attractive packs. The stalks should be cut in $\frac{1}{2}$-1 inch lengths, blanched for three-quarters of a minute in boiling water and chilled. Cans or cartons may be used as containers, and 50°B. sugar syrup has been found to be a satisfactory covering liquid. Blanching is not necessary, but it facilitates packing by softening the pieces. Rhubarb may also be packed as full-length or cut stalks in moisture-proof wraps or containers, no blanch being given. The latter method is most suitable for commercial use, but for home use the syrup pack has been found to be easier to handle and to retain better flavour.

## PREPARATION OF FROZEN PRODUCTS FOR THE TABLE

For dessert purposes frozen fruits retain better colour, flavour and form if allowed to thaw slowly in an ice box or refrigerator. The time necessary will be from 6 to 8 hours. Strawberries, raspberries and blueberries may be taken from the carton and thawed in a glass, china or enamelled dish. Peaches and sweet cherries, which are subject to browning, should be allowed to thaw in the

unopened container to avoid contact with air. When thawed, fruits deteriorate rapidly; for this reason they should be served just before they are completely thawed. Fruits used for pie-making should be about half thawed before they are put in the pie, and flour, starch or tapioca should be added to stiffen the juice.

As a general rule, a frozen vegetable should be cooked for about one-half the time recommended for the fresh vegetable. Dry-packed vegetables should be cooked in about one-half their weight of water; they cook better in water than in steam. As frozen vegetables do not stand up well on the steam table they should be cooked as required and in small lots. They should be allowed to defrost partially before cooking as this facilitates their removal from the container.

Vegetables packed in brine should be cooked in it, only a very small amount of water being added. After the carton is torn off, the frozen pack is put in a pan with a little water, covered and placed on the stove. Defrosting takes about ten minutes.

## SALE OF CANNED GOODS

Attention is drawn to the following requirements under the Meat and Canned Foods Act.

"Canned Foods" includes foods except fish and shell fish that have been preheated, cooked, preserved, condensed, evaporated, dehydrated, dried or otherwise processed or prepared for food, and are placed in any closed can, bottle, package or container.

28. (3) All canned fruits or vegetables or products thereof or any food or food products except fish and shell fish which may be named by the Governor in Council, shall be offered for sale only in such cans or other containers as the Governor in Council may by regulations prescribe, and such cans or containers must contain the quality, quantity, or weight prescribed by the regulations.

OTTAWA: Printed by J. O. PATENAUDE, I.S.O., Printer to the King's Most Excellent Majesty, 1937.